

INTERFACING WIND SYSTEMS WITH THE UTILITY GRID

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SUMMARY:

The methods and factors that must be weighed in the interconnection of wind energy systems with a utility grid for supplying electrical power are presented in relation to performance and application. For best utilization of wind systems, these factors must be carefully considered to ensure safety and performance.



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Abstract

The methods and factors that must be weighed in the interconnection of wind energy systems with a utility grid for supplying electrical power are presented in relation to performance and application. For best utilization of wind systems, these factors must be carefully considered to ensure safety and performance.

Introduction

Small wind energy conversion systems (SWECS) offer the possibility of reducing our use of nonrenewable energy resources and making a positive contribution to the solution of our energy problems, particularly in rural areas. Economic considerations are one of the major obstacles to the widespread use of many alternative energy systems. For wind systems intended for supplying electrical power at the conventional voltage of 120 volts and a frequency of 60 Hz, storing any substantial amount of electrical energy for conversion by means such as batteries is, in most instances, prohibitive in cost. Typically, lead-acid batteries have an energy density of 10 watt-hours per pound, are good for about 1500 charge-discharge cycles, and cost \$80/kilowatt-hour (1). Consequently, using methods for energy storage other than batteries or avoiding energy storage are desirable if the economics of a wind system are to be made as effective as possible.

Utility Interfacing

There presently are two general methods being used for supplying normal 120/240 volt, AC requirements for agricultural applications without energy storage from SWECS. These are the use of an induction generator or the use of a synchronous inverter connected to the utility-supplied electrical service.

For both types of utility interface, if the power line drops out, the wind system will not supply line power under normal conditions. It

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is possible, however, to use a wind system without utility power if the wind system can be connected to an auxiliary generator of proper size in relation to wind-system capacity.

Induction Generators

An induction generator is essentially an AC motor, driven at a speed above its normal synchronous speed. The induction generator has a number of advantages: low cost, simplicity, and, because of its relatively constant-speed characteristics, accommodation of a wide upper wind speed range without generator overload.

The induction generator is not without disadvantages; however, some type of automatic disconnecting means must be provided if the rotational speed is below synchronous speed, or the generator will become a motor. This problem may be overcome by several methods such as a wind speed or a rotational speed monitor to make the connection only if the proper conditions are met. Because the possibility does exist that the unit may become self-excited, it is necessary to ensure that, in case of utility power failure, the unit will be disconnected from the line. Because this generally will unload the generator, it becomes essential to provide some method of preventing an overspeed condition. Also, the excitation causes a lagging power factor; the coefficient of performance drops off as wind speeds exceed an upper level, and, because the unit must be up to speed to generate, it cannot capture energy below a lower threshold that may be somewhat greater than for other systems.

Synchronous Inverters

A synchronous inverter generally is a solid-state device that can take a variable DC voltage input and apply this energy to the AC line. Usually the DC is produced by a wind-driven alternator and rectified for application to the inverter. An inductor may be required to interface the rectified DC output with the converter and may add substantially to the cost.

Synchronous inverters can operate without energy storage as with induction generators but also have the capability of operating with stored DC energy from batteries if the power line voltage is present for synchronization. For many configurations, it also would be possible, if line power were lost, to use the alternator output on a "stand alone basis" for such purposes as resistance heating for which variable voltage and frequency are satisfactory.

The primary disadvantages are a higher system cost than an induction generator, a greater complexity than an induction generator that makes service problems greater, and a reduction of system efficiency at loads that are less than rated converter power capability.

Safety

There are a number of concerns related to interfacing of cogenerated power with a utility. Foremost of these is the safety of utility personnel working on the utility lines. This will require careful consideration of positive disconnection or disabling means for each type of interface.

Power System Considerations

In addition to safety, there are a number of additional concerns that merit attention. The first of these are possible effects on system operation. If a large number of SWECS are interfaced on a given system, problems such as over or under voltage, current, and frequency as well as harmonics, flicker, and reactive power requirements may be present. A second concern relates to the supply system. Protection coordination, line or generator tripping, load modeling, and stability analysis may become more of a problem. Possible damage to either utility or customer equipment also must be considered.

Payback for Cogenerated Power

Present regulations of the Federal Energy Regulatory Commission through the Public Utilities Regulatory Policies Act of 1978 make it mandatory for many power suppliers, not only to accept power from cogeneration facilities but also to provide cost information as to the payback rate that will be made for cogenerator power. This mandatory acceptance and payback, however, is based on the "avoided" cost to the utility.

For normal rate structures, the rebate for power fed back into the line will not be at the retail rate. Although policies vary widely at present, credit for power generated usually will be at a rate considerably less than retail. This makes utilization of wind-generated and interfaced power of greatest economic value if it can be used on site.

Metering

Present practices for metering vary, but a common approach for metering used and fed back power is to meter with two ratchetted meters as shown in Fig. 1. One meter reads the power supplied by the utility to the customer while the second meter reads only power fed back to the utility line.

In the future, as rate structures become established, the value of the cogenerated power may be related to the time of day (TOD) that power is supplied. When power is fed back to the utility at times when the generators are idling and generation capacity far exceeds demand, the value of cogenerator power is very low. Consequently, metering of power returned to the utility will most likely require some form of TOD metering.

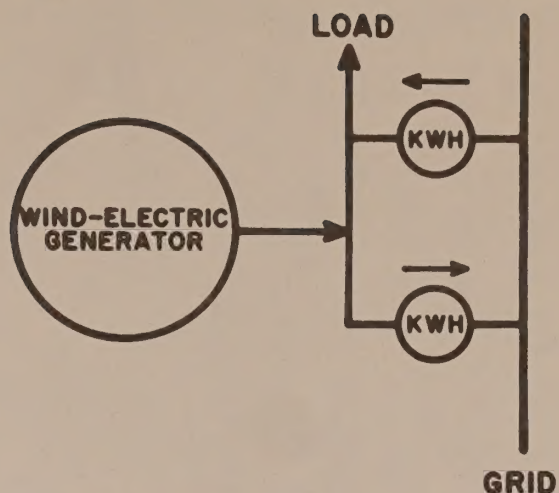


Fig. 1. Ratchetted meter connections for metering utility supplied and wind-system fed back power

There are no clearly established rules or methods for interfacing SWECS to a utility at present, but a large number of power suppliers are experimenting with interconnection methods and monitoring interconnection power return and effects. Undoubtedly, in the next couple of years, as interconnected SWECS become widespread, practices and procedures will become more clearly defined. In the meantime, however, it seems essential that careful consideration be given to all interconnections of SWECS with utility power so that both safety and practicality may be served.

Conclusions

Interfacing of wind systems to a utility power system presents a number of both opportunities and problems. For the best utilization of wind power systems for helping solve our energy problems, careful consideration must be given to both the application and interface techniques to ensure safety and performance.

References

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